TSG-RAN Working Group 1 meeting #10 **_TSGR1-00-0034_**
Beijing, China, 18th - 21st , Jan., 2000

Agenda Item :

Source : LG Information & Communications, Ltd.

Title : SSDT cell ID codes and their performance evaluation

Document for : Decision

Abstract

This document shows the minimum Hamming distance of SSDT cell ID codes of the current codes, Samsung codes and proposed LGIC codes. Since the proposed SSDT cell ID codes have the maximized minimum Hamming distance, we can obtain the significant performance gain not only in AWGN but also in Fading channel. Therefore, we propose that the current SSDT cell ID codes should be replaced with proposed ones, which is optimized in terms of the minimum Hamming distance.

1. Introduction

This document presents the performance comparison among Site selection diversity transmit (SSDT) cell identification (ID) codes of current [1], Samsung [2], and LGIC [3] in not only AWGN but also Fading channel.

At the last meeting in Dresden, since a concern regarding simulation assumption was raised, to clarify this concern, Samsung and LGIC made liaison [4] together and the approved liaison [5] from WG1 was sent to WG3. The following is the response liaison from WG3 [6] ;

WG1 Q1. Would it be possible to dynamically allocate the SSDT ID codes of cells by high layer signaling for more reliable radio link maintenance?

WG3 Answer: The WG3 procedures do not support dynamic allocation of SSDT cell ID during operation of SSDT. However, SSDT cell id may be reallocated by deactivating and reactivating SSDT with the Radio link reconfiguration procedure.

WG1 Q2. Does the Node B know whether the UE is in the mode of soft handover or not?

WG3 Answer: No

WG1 Q3. Does the Node B have the knowledge about the SSDT ID codes of other Node Bs?

WG3 Answer: No

WG1 Q4.Current SSDT code ID allocation procedure in UTRAN.

WG1 Q5 Way of the maintenance of Radio Link ID-SSDT ID mapping table in UTRAN

WG3 Answer to Q4 and Q5: WG3 has no intention to standardise the mapping table or procedure of SSDT cell ID allocation.

This document presents the simulation results based on the above response from WG3. We propose that [3] from LGIC should be accepted in this meeting since this shows the best performance among [1]-[3] and has the benefit in terms of minimum Hamming distance.

2. SSDT ID Codes

2.1. Current

There are three different lengths of coded ID available denoted as "long", "medium" and "short". The network decides which length of coded ID is used. Settings of current ID codes for 1-bit and 2-bit FBI are exhibited in table 1 and table 2, respectively.

Table 1: Settings of ID codes for 1 bit FBI (CURRENT)

ID label	ID code "long"	"medium"	"short"
A	000000000000000	0000000(0)	00000
B	111111111111111	1111111(1)	11111
C	000000001111111	0000111(1)	00011
D	111111110000000	1111000(0)	11100
E	000011111111000	0011110(0)	00110
F	111100000000111	1100001(1)	11001
G	001111000011110	0110011(0)	01010
H	110000111100001	1001100(1)	10101

Table 2: Settings of ID codes for 2 bit FBI (CURRENT)

ID label	ID code (Column and Row denote slot position and FBI-bit position.) "long"	"medium"	"short"
A	0000000(0) 0000000(0)	000(0) 000(0)	000 000
B	1111111(1) 1111111(1)	111(1) 111(1)	111 111
C	0000000(0) 1111111(1)	000(0) 111(1)	000 111
D	1111111(1) 0000000(0)	111(1) 000(0)	111 000
E	0000111(1) 1111000(0)	001(1) 110(0)	001 100
F	1111000(0) 0000111(1)	110(0) 001(1)	110 011
G	0011110(0) 0011110(0)	011(0) 011(0)	010 010
H	1100001(1) 1100001(1)	100(1) 100(1)	101 101

From the table 1, we see that the minimum Hamming distance of ID codes for 1 bit FBI is:

- d_{min} = 7 for long code of length 15
- d_{min} = 4 for medium code of length 8
- d_{min} = 3 for punctured medium code of length 7
- d_{min} = 2 for short code of length 5

And from table 2, the minimum Hamming distance of ID codes for 2 bit FBI is:

- d_{min} = 8 for long code of length 16
- d_{min} = 6 for punctured long code of length 14
- d_{min} = 4 for medium code of length 8
- d_{min} = 2 for punctured medium code of length 6
- d_{min} = 2 for short code of length 6

2.2. Samsung

Table 3: Settings of ID codes for 1 bit FBI (Samsung)

ID label	ID code "long"	"medium"	"short"
A	000000000000000	0000000(0)	00000
B	111111111111111	1111111(1)	11111
C	010101010101010	0101010(1)	01010
D	101010101010101	1010101(0)	10101
E	001100110011001	0011001(1)	00110
F	110011001100110	1100110(0)	11001
G	011001100110011	0110011(0)	01100
H	100110011001100	1001100(1)	10011

Table 4: Settings of ID codes for 2 bit FBI (Samsung)

ID label	ID code (Column and Row denote slot position and FBI-bit position.) "long"	"medium"	"short"
A	0000000(0) 0000000(0)	000(0) 000(0)	000 000
B	1111111(1) 1111111(1)	111(1) 111(1)	111 111
C	0000000(0) 1111111(1)	000(0) 111(1)	000 111
D	1111111(1) 0000000(0)	111(1) 000(0)	111 000
E	0101010(1) 0101010(1)	010(1) 010(1)	010 010
F	1010101(0) 1010101(0)	101(0) 101(0)	101 101
G	0101010(1) 1010101(0)	010(1) 101(0)	010 101
H	1010101(0) 0101010(1)	101(0) 010(1)	101 010

From the table 3, we see that the minimum Hamming distance of ID codes for 1 bit FBI is:

- d_{min} = 7 for long code of length 15
- d_{min} = 4 for medium code of length 8
- d_{min} = 3 for punctured medium code of length 7
- d_{min} = 2 for short code of length 5

And from table 4, the minimum Hamming distance of ID codes for 2 bit FBI is:

- d_{min} = 8 for long code of length 16
- d_{min} = 6 for punctured long code of length 14
- d_{min} = 4 for medium code of length 8
- d_{min} = 2 for punctured medium code of length 6
- d_{min} = 2 for short code of length 6

2.3. LGIC

The followings are proposed SSDT cell ID codes and we see there is benefit in terms of minimum Hamming distance.

Table 5: Settings of ID codes for 1 bit FBI (LGIC)

ID label	ID code "long"	"medium"	"short"
A	000000000000000	(0)0000000	00000
B	101010101010101	(0)1010101	01001
C	011001100110011	(0)0110011	11011
D	110011001100110	(0)1100110	10010
E	000111100001111	(0)0001111	00111
F	101101001011010	(0)1011010	01110
G	011110000111100	(0)0111100	11100
H	110100101101001	(0)1101001	10101

Table 6: Settings of ID codes for 2 bit FBI (LGIC)

ID label	ID code (Column and Row denote slot position and FBI-bit position.) "long"	"medium"	"short"
A	(0)0000000 (0)0000000	(0)000 (0)000	000 000
B	(0)0000000 (1)1111111	(0)000 (1)111	000 111
C	(0)1010101 (0)1010101	(0)101 (0)101	101 101
D	(0)1010101 (1)0101010	(0)101 (1)010	101 010
E	(0)0110011 (0)0110011	(0)011 (0)011	011 011
F	(0)0110011 (1)1001100	(0)011 (1)100	011 100
G	(0)1100110 (0)1100110	(0)110 (0)110	110 110
H	(0)1100110 (1)0011001	(0)110 (1)001	110 001

From the table 5, we see that the minimum Hamming distance of proposed ID codes for 1 bit FBI is:

- d_{min} = 8 for long code of length 15
- d_{min} = 4 for medium code of length 8
- d_{min} = 4 for punctured medium code of length 7
- d_{min} = 2 for short code of length 5

And from table 6, the minimum Hamming distance of ID codes for 2 bit FBI is:

- d_{min} = 8 for long code of length 16
- d_{min} = 7 for punctured long code of length 14
- d_{min} = 4 for medium code of length 8
- d_{min} = 3 for punctured medium code of length 6
- d_{min} = 3 for short code of length 6

Thus the proposed LGIC codes have the benefits in terms of the minimum Hamming distance than Current and Samsung.

2.4. Minimum Hamming Distance Comparison

The following two tables denote the minimum Hamming distance among three different SSDT ID codes. We find that the SSDT ID codes of Samsung have the same minimum Hamming distance as the Current codes. Whereas, the proposed codes have the maximized minimum Hamming distance.

Table 7. The minimum Hamming distance between Current, Samsung, and LGIC in the case of 1 bit FBI.

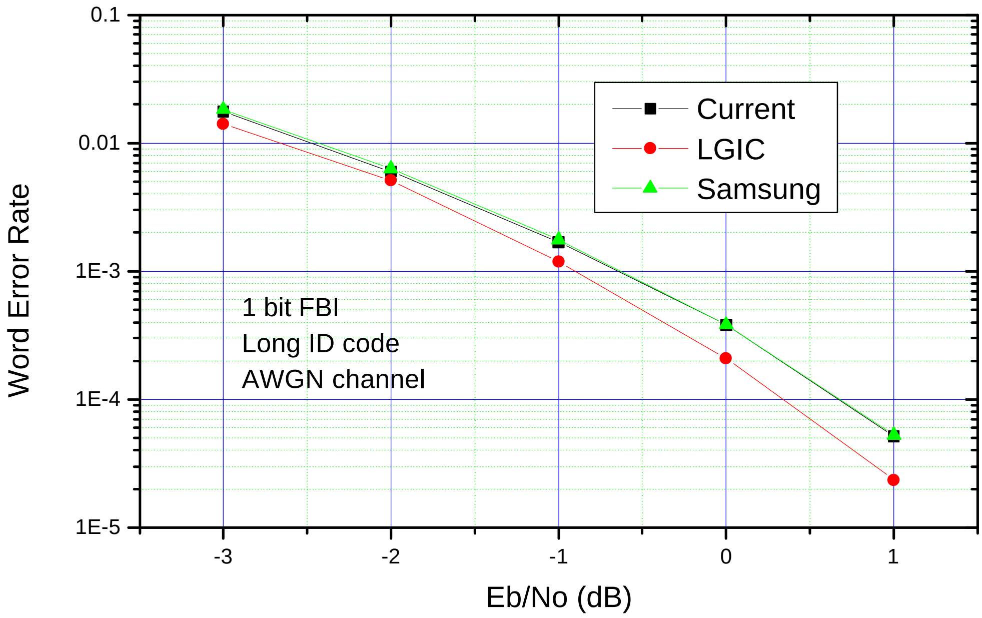
	1 bit FBI			
	Long code of length 15	**Medium code of length 8**	**Medium code of length 7**	**Short**
Current	**7**	**4**	**3**	**2**
Samsung	**7**	**4**	**3**	**2**
LGIC	**8**	**4**	**4**	**2**

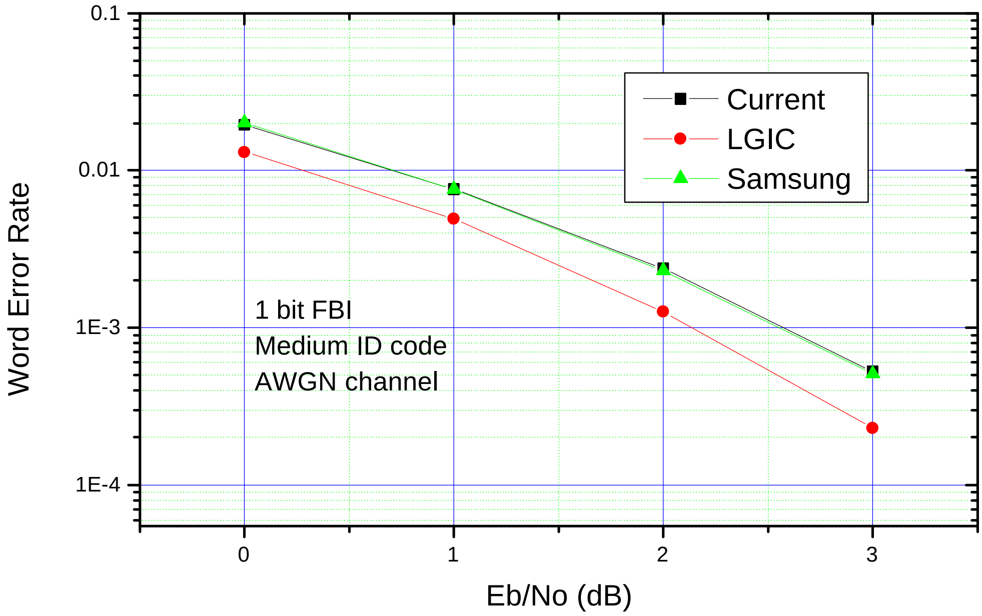
Table 8. The minimum Hamming distance between Current, Samsung, and LGIC in the case of 2 bit FBI.

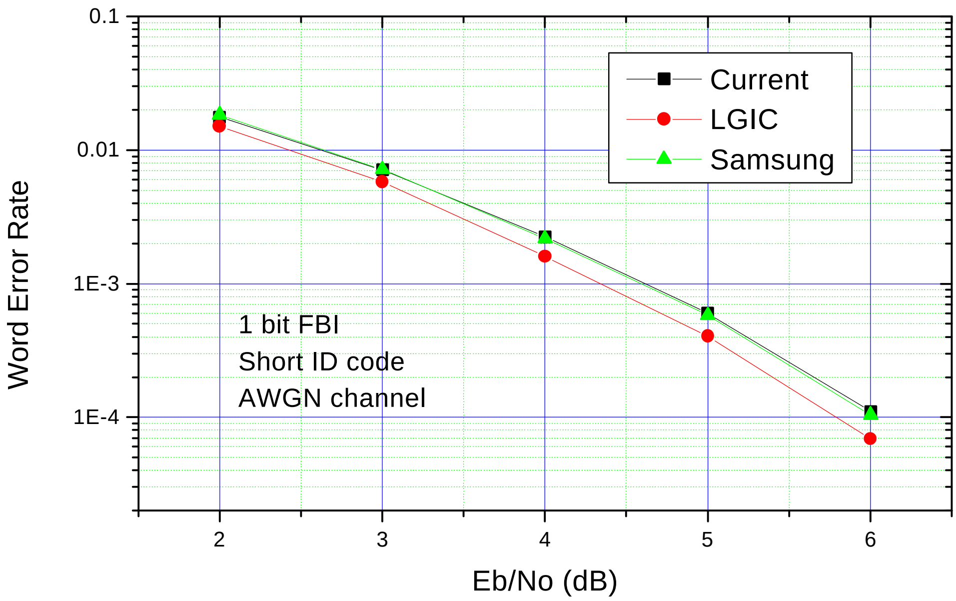
	2 bit FBI				
	Long code of length 16	**Long code of length 14**	**Medium code of length 8**	**Medium code of length 7**	**Short**
Current	**8**	**6**	**4**	**3**	**2**
Samsung	**8**	**6**	**4**	**3**	**2**
LGIC	**8**	**7**	**4**	**4**	**3**

3. Performance evaluation

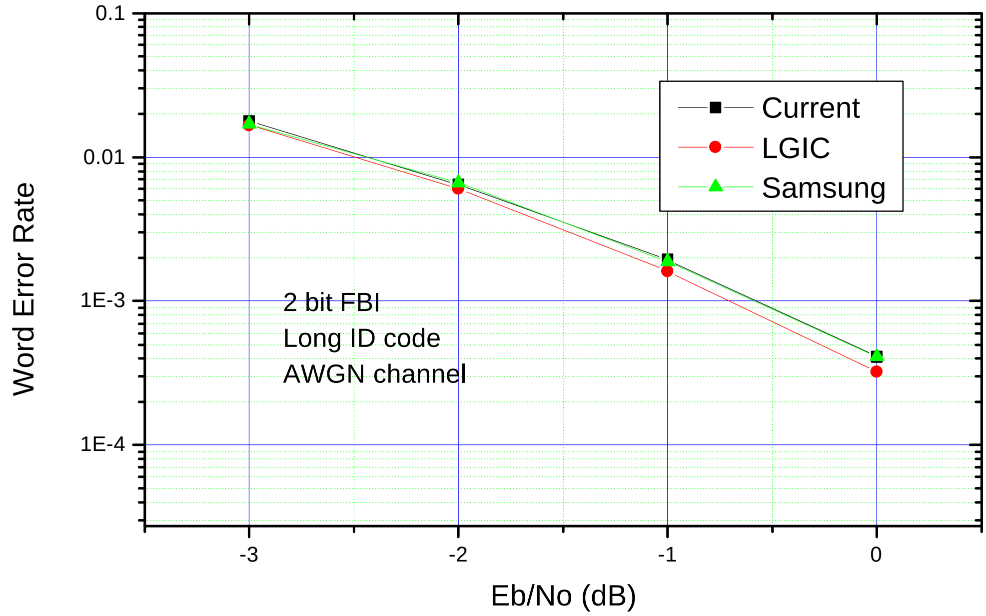
3.1. AWGN channel (1 bit FBI)

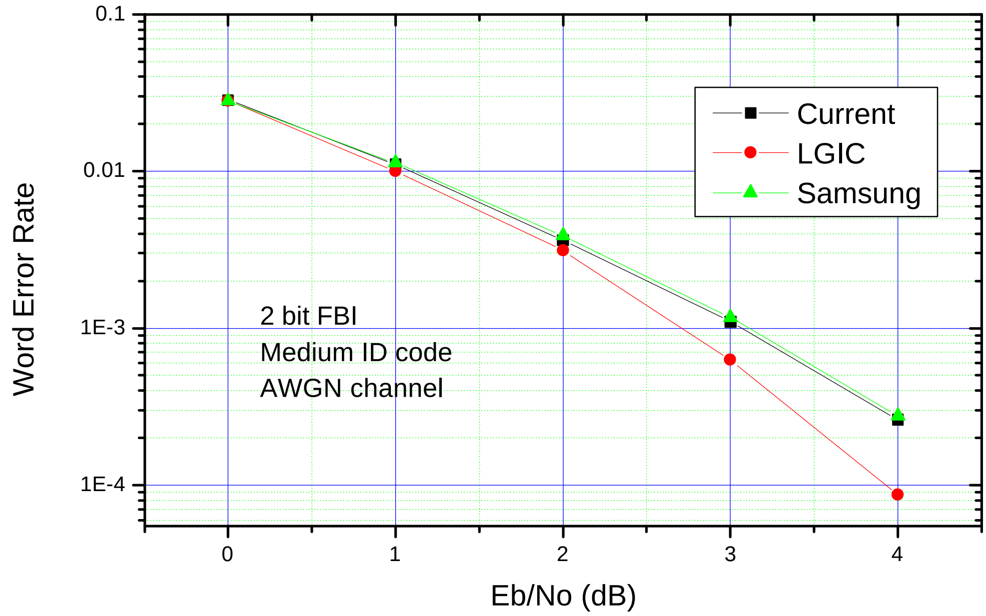






3.2. AWGN (2 bit FBI)


0.1
0.01
1E-3
1E-4
Word Error Rate
-3
-2
-1
0
Eb/No (dB)
Current
LGIC
Samsung
2 bit FBI
Long ID code
AWGN channel


0.1
0.01
1E-3
1E-4
Word Error Rate
0
1
2
3
4
Eb/No (dB)
Current
LGIC
Samsung
2 bit FBI
Medium ID code
AWGN channel

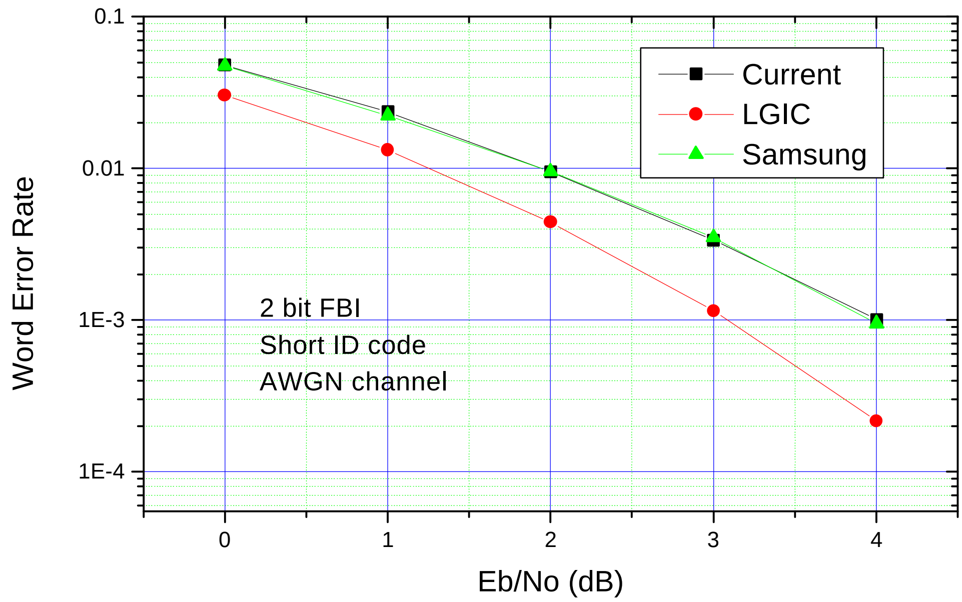


Table 9. Performance gain difference (dB) between different ID codes in AWGN channel, reference is Current ID codes.

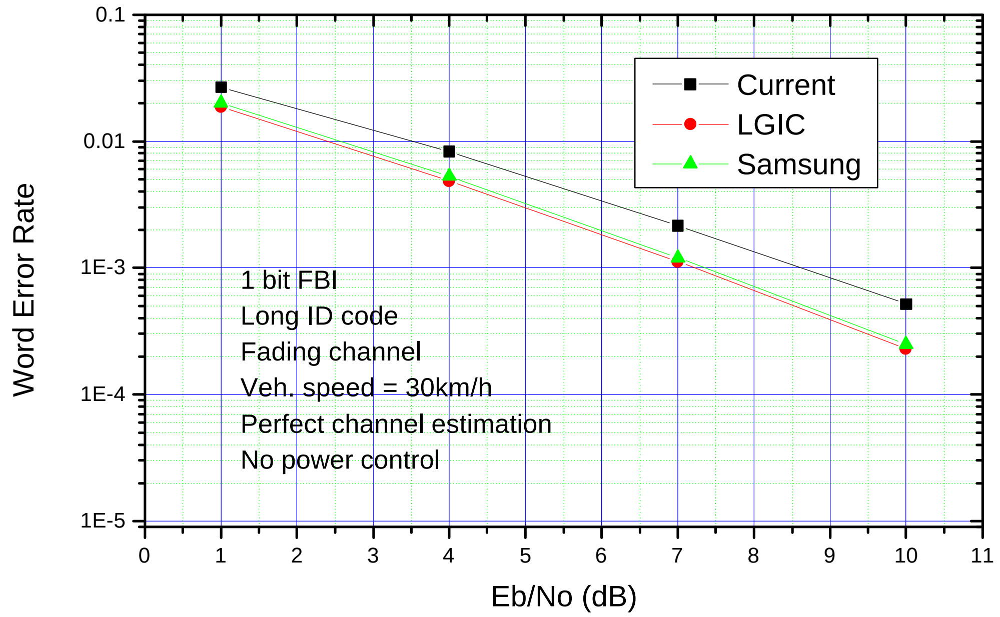
AWGN channel	**1 bit FBI**			**2 bit FBI**		
	Long	**Medium**	**Short**	**Long**	**Medium**	**Short**
Current	**0**	**0**	**0**	**0**	**0**	**0**
Samsung	**0**	**0**	**0**	**0**	**0**	**0**
LGIC	**0.3**	**0.4**	**0.3**	**0.2**	**0.4**	**0.9**

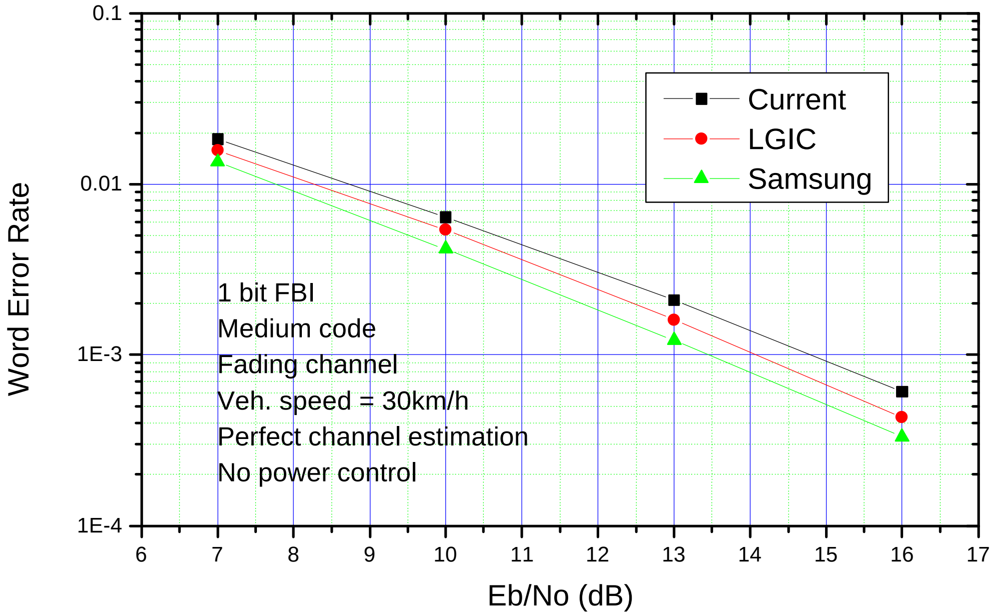
4. Fading Channel

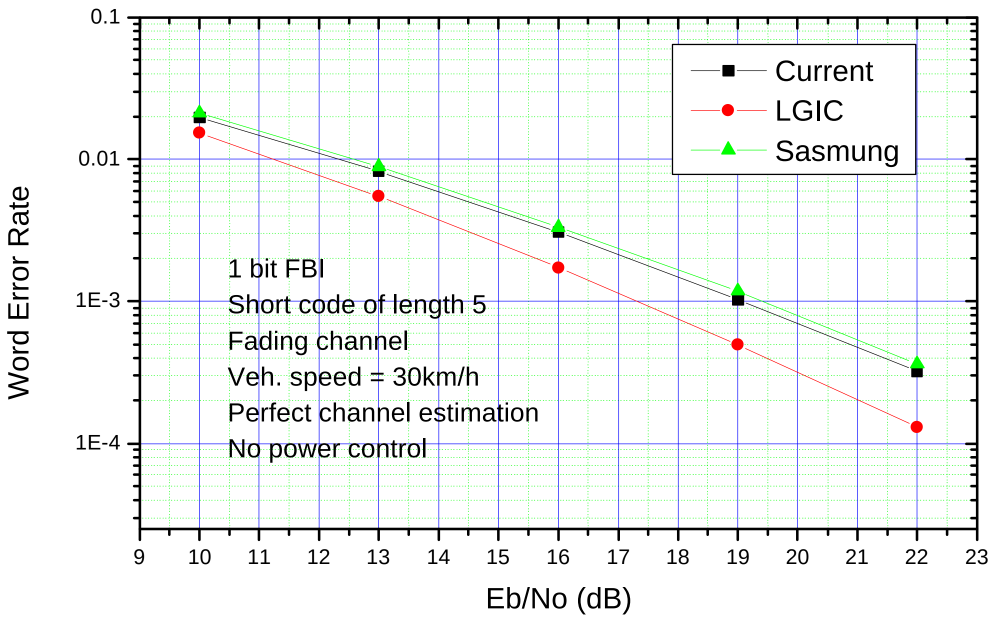
Simulation condition:
- 1path
- Perfect channel estimation
- No power control
- Vehicular Speed = 30km/h and 120km/h,

4.1. Fading channel (30km/h)

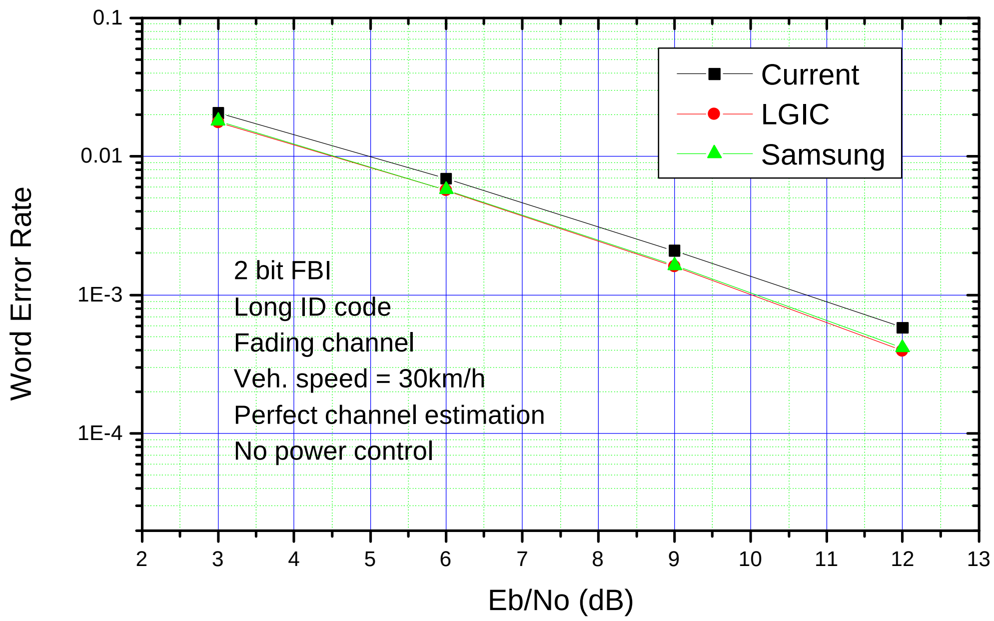
- 1 bit FBI



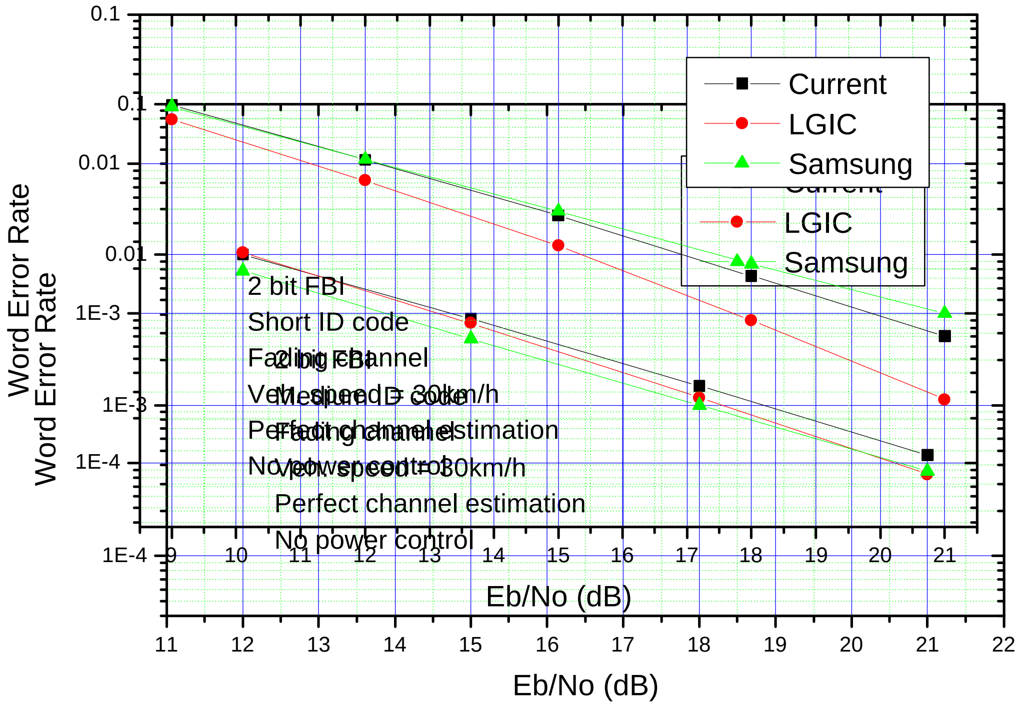

Word Error Rate
0.1
0.01
1E-3
1E-4
6
7
8
9
10
11
12
13
14
15
16
17
Eb/No (dB)
Current
LGIC
Samsung
1 bit FBI
Medium code
Fading channel
Veh. speed = 30km/h
Perfect channel estimation
No power control


Word Error Rate
0.1
0.01
1E-3
1E-4
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Eb/No (dB)
Current
LGIC
Sasmung
1 bit FBI
Short code of length 5
Fading channel
Veh. speed = 30km/h
Perfect channel estimation
No power control

● 2 bit FBI



Word Error Rate
Eb/No (dB)
Current
LGIC
Samsung
2 bit FBI
Long ID code
Fading channel
Veh. speed = 30km/h
Perfect channel estimation
No power control



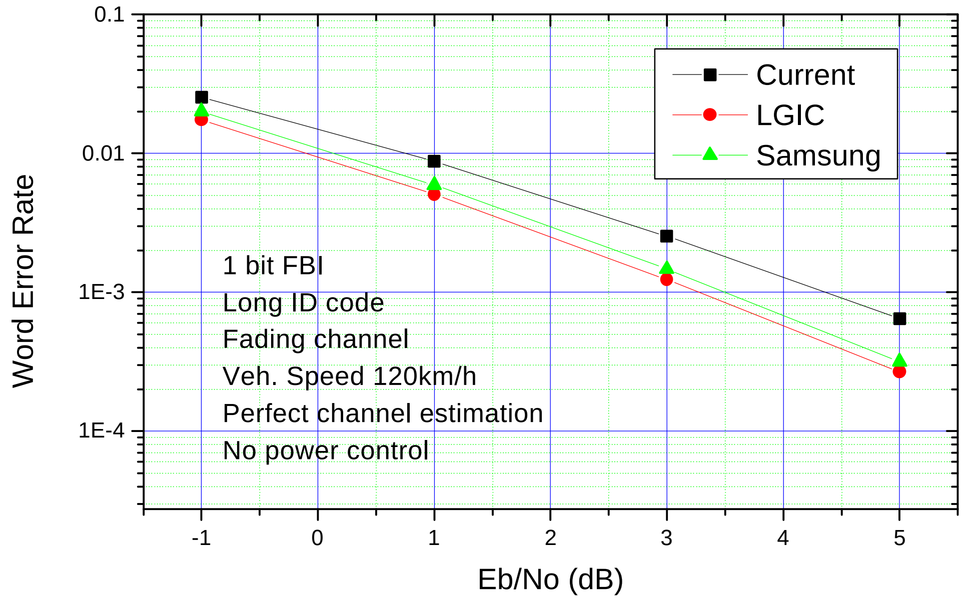
Word Error Rate
Eb/No (dB)
Current
LGIC
Samsung
2 bit FBI
Short ID code
Perfect channel estimation
No power control

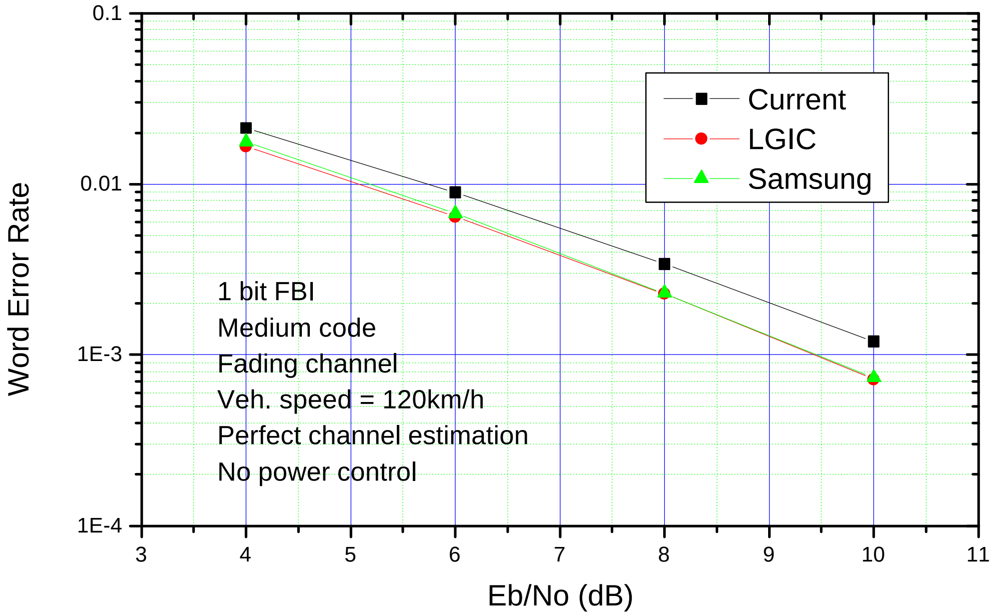
Table 10. Performance gain difference (dB) between different ID codes in Fading channel of 30km/h, reference is Current ID codes.

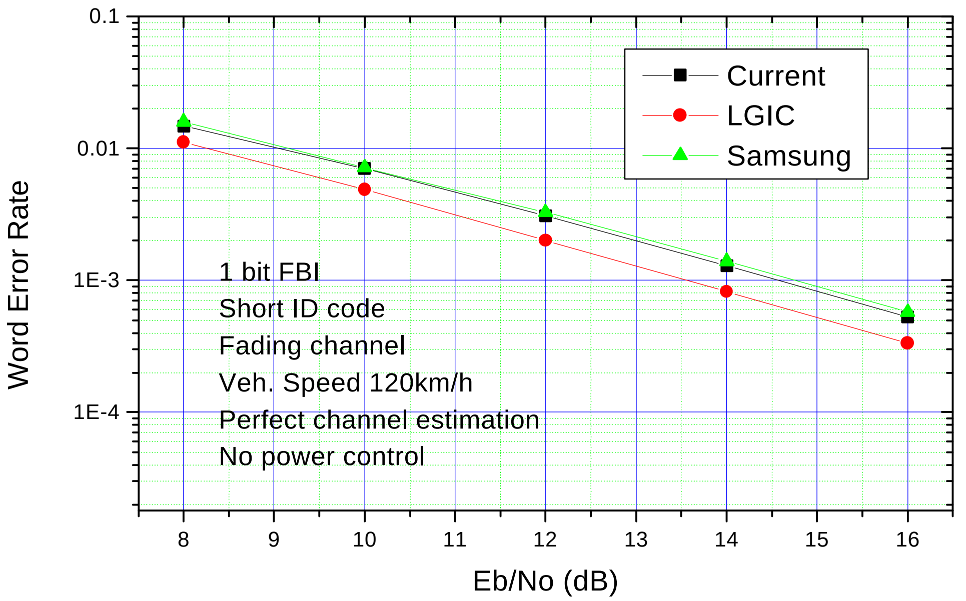
30km/h	1 bit FBI			2 bit FBI		
	Long	**Medium**	**Short**	**Long**	**Medium**	**Short**
Current	**0**	**0**	**0**	**0**	**0**	**0**
Samsung	**1.3**	**1.3**	**-0.5**	**0.8**	**0.8**	**-1.0**
LGIC	**1.5**	**0.8**	**1.8**	**0.8**	**0.6**	**2.2**

4.2. Fading channel (120km/h)

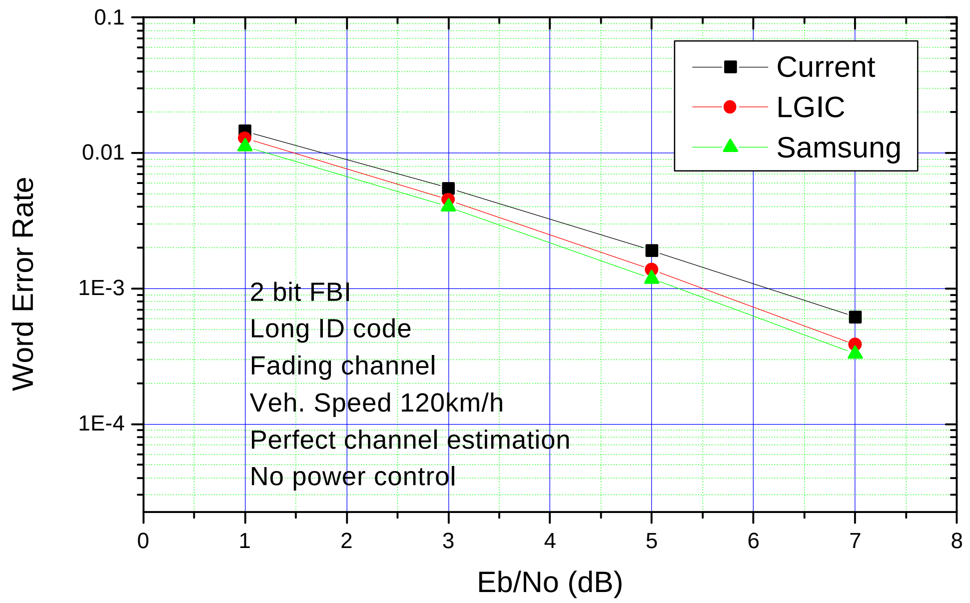
- 1 bit FBI



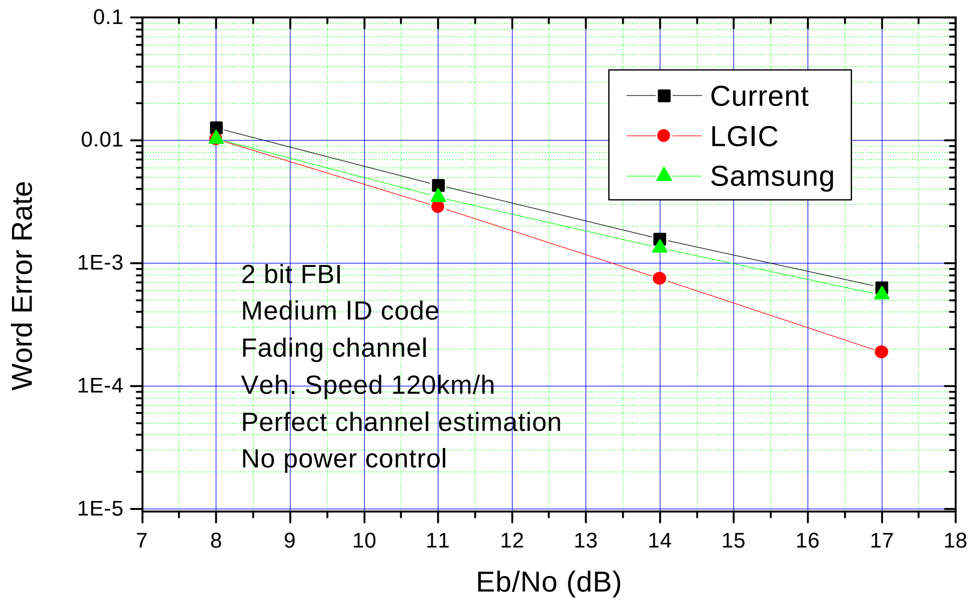

Current
LGIC
Samsung
1 bit FBI
Medium code
Fading channel
Veh. speed = 120km/h
Perfect channel estimation
No power control
Word Error Rate
Eb/No (dB)
0.1
0.01
1E-3
1E-4
3
4
5
6
7
8
9
10
11


Current
LGIC
Samsung
1 bit FBI
Short ID code
Fading channel
Veh. Speed 120km/h
Perfect channel estimation
No power control
Word Error Rate
Eb/No (dB)
0.1
0.01
1E-3
1E-4
8
9
10
11
12
13
14
15
16

- 2 bit FBI



0.1
0.01
1E-3
1E-4
Word Error Rate
0
1
2
3
4
5
6
7
8
Eb/No (dB)
Current
LGIC
Samsung
2 bit FBI
Long ID code
Fading channel
Veh. Speed 120km/h
Perfect channel estimation
No power control



0.1
0.01
1E-3
1E-4
1E-5
Word Error Rate
7
8
9
10
11
12
13
14
15
16
17
18
Eb/No (dB)
Current
LGIC
Samsung
2 bit FBI
Medium ID code
Fading channel
Veh. Speed 120km/h
Perfect channel estimation
No power control

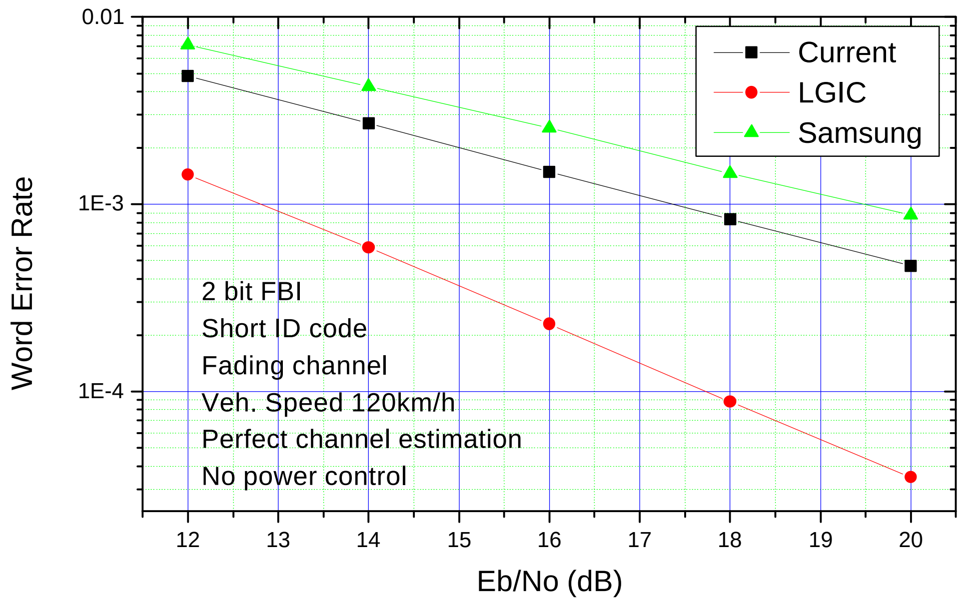


Table 11. Performance gain difference (dB) between different ID codes in Fading channel of 120km/h, reference is Current ID codes.

120km/h	1 bit FBI			2 bit FBI		
	Long	**Medium**	**Short**	**Long**	**Medium**	**Short**
Current	**0**	**0**	**0**	**0**	**0**	**0**
Samsung	**0.8**	**0**	**0**	**0.9**	**0.5**	**-2.0**
LGIC	**1.1**	**0.8**	**1.0**	**0.7**	**2.0**	**4.7**

5. Conclusion

In this contribution, the performance and the minimum Hamming distance comparisons among Current, Samsung, and LGIC SSDI ID codes were given. We found that LGIC proposal [3] shows the best performance not only in AWGN but also in Fading channel since the proposed codes are optimized in terms of minimum Hamming distance. In the case of short code of 2 bit FBI, the proposed code obtains about 3 ~ 6.7 dB performance gain in Fading channel compared to Samsung code. Furthermore, in this case Samsung code shows the worst performance. Thus, we propose that [3] should be accepted.

References

[1] "UTRA FDD ; Physical layer procedures", 3GPP TS25.214, v3.1.0 (1999-12).
[2] Samsung, "SSDT ID code (rev.1)", R1#9(99)K91.
[3] LGIC, "CR 25.214-043 ; Optimum ID Codes for SSDT Power Control", R1-00-0012.
[4] LGIC and Samsung, "Proposed LS on Higher Layer Signaling for Site Selection Diversity Transmission Power Control", TSGR1#9(99)L49.
[5] WG1, "Proposed LS on Higher Layer Signaling for Site Selection Diversity Transmission Power Control", TSGR1#9(99)L74.
[6] WG3, "Response to LS on Higher Layer Signaling for Site Selection Diversity Transmission Power Control", TSGR1-00-0008.